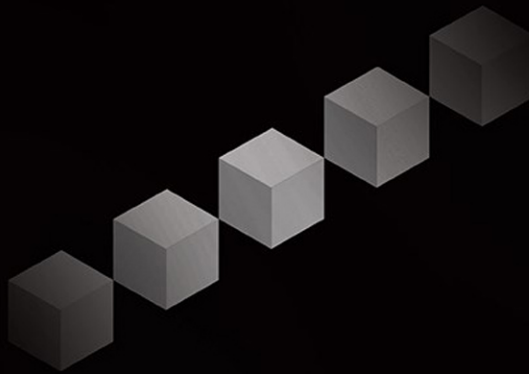# BLOCKCHAIN

FOR BUSINESS

Discover How Blockchain Networks
Are Transforming Companies, Driving Growth,
and Creating New Business Models

JAI SINGH ARUN   **JERRY CUOMO**   **NITIN GAUR**

Foreword by DON TAPSCOTT

Praise for
Blockchain for Business

"Much has been written about blockchain in the past few years: what it is and what it is not (at various levels of detail), as well as the technology's long-term strategic value for companies, industries, and economies. However, what we've been missing is a practical, operational, 'how to' set of steps for creating, implementing, and operating a blockchain-based solution. This book aims to fill that gap. It's an invaluable tool for anyone ready to take the plunge and start taking advantage of this remarkable technology.

"Most technologies can be implemented one business at a time. Not so with blockchain. Blockchain is particularly valuable when applied to a collection of companies working closely together as a business ecosystem, such as a supply chain. *Blockchain for Business* goes into great detail about what it takes to organize and manage such an ecosystem, including the technical and business models that in the end drive the decisions about whether to join or not, and the governance necessary for a smooth, efficient operations. It also nicely explains the necessary technical expertise and management roles needed to successfully create and operate blockchain frameworks and applications.

"*Blockchain for Business* is an invaluable tool for anyone ready to take the plunge and start taking advantage of this remarkable technology."

—*Irving Wladawsky-Berger, Research Affiliate, MIT; Columnist, WSJ CIO Journal; VP Emeritus, IBM*

"Jai, Jerry, and Nitin have written the guidebook to address the critical knowledge gap that exists between the hype of blockchain and cryptocurrencies and the pragmatic utilization of blockchain technology for transforming businesses. *Blockchain for Business* leverages their firsthand insights and provides a practical approach for business and technical leaders

to leverage a proven methodology to drive successful blockchain projects that deliver trust and transparency for all participants."

—Marie Wieck, General Manager, IBM Blockchain

"Understand how to capture the power of the trust machine. This book contains a wealth of resources and tools for those looking to apply blockchain solutions in a business environment. A must-read for enterprise executives."

—Perianne Boring, Founder and President,
Chamber of Digital Commerce

"Jai, Jerry, and Nitin nailed it! *Blockchain for Business* addresses the critical question business leaders are attempting to answer: How does my business derive real, measurable value from blockchain? This is a practical guidebook for both the business and technology leader to help identify business value from blockchain technology in the form of new growth opportunities, sustainable competitive advantage, time savings, cost reductions, and risk mitigation—turning blockchain into business results!"

—D. Keith Pigues, CEO and Founder, Luminas Strategy, Coauthor
Winning with Customers: A Playbook for B2B

"*Blockchain for Business* is a must-read for executives looking to define blockchain's potential to transform business processes. Jerry, Jai, and Nitin have comprehensively described the key steps business leaders should take to identify the right scope, select the best technology, and establish an appropriate business model and governance structure."

—Arvind Krishna, SVP, Hybrid Cloud and
Director of IBM Research

BLOCKCHAIN FOR BUSINESS

Jai Singh Arun

Jerry Cuomo

Nitin Gaur

♦♦Addison-Wesley

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Dedicated to

My mom and dad, Saroopi Devi and Phusiya Ram, who gave me existence in this world; my siblings, who encourage me with admiration; my darling Varshal, who strengthens my soul with love and inspires me; my daughter Saachi and son Yogya, who enlighten me with joy every day.

And in memory of my loving brother Mr. Omprakash Arun (1968–2013); my angel sister Ms. Babita Arun (1988–2016); and my respected father-in-law Mr. Chandrahas Mayekar (1943–2016).
—Jai Singh Arun

My darling Steph. Not since Lennon and McCartney has there been a more prolific pair of composers like the two of us.
—Gennaro Cuomo

My parents, for their unconditional love; my spouse Ritu, for her unconditional support; and my son Neil, who inspires me every day.
—Nitin Gaur

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FOREWORD

I'm delighted to provide some context for this enormously thoughtful and eminently practical book, *Blockchain for Business.*

When Alex Tapscott and I wrote the first edition of *Blockchain Revolution* in 2016, we characterized blockchain as a platform for conducting transactions of value. We explained that for nearly four decades, we had the Internet of information. It vastly improved the flow of data within and among firms and people, but it didn't transform the deep architecture of the firm. That's because the Internet was designed to move information from person to person. It wasn't designed to solve what cryptographer David Chaum called the "double-spend problem," the ability to spend a single digital dollar in two places online.[1]

Now for the first time ever we have a native digital medium for value, through which we can transfer any asset—from money and music to votes and intellectual property—peer to peer in a secure and private way. Trust

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1. David Chaum. "Blind Signatures for Untraceable Payments." *Advances in Cryptology: Proceedings of Crypto 82* (January 1982): 199–203.

is achieved not necessarily by intermediaries like banks or governments, but by cryptography, collaboration, and clever code.

Based on the success of the book, Alex and I founded the Blockchain Research Institute (BRI), a think tank dedicated to investigating blockchain use cases and the leadership required to drive experimentation and change in an organization. Our membership has grown to include global corporations, governments, nonprofit organizations, and members of the blockchain start-up community.

IBM's CEO, Ginni Rometty, recognized the transformative potential of blockchain technology early on, and IBM became a founding member of the BRI. Gennaro "Jerry" Cuomo, co-author of this book, participated in the opening panel of the BRI's first all-member summit in the fall of 2017. His contributions were invaluable to the executives in attendance. Since then, we've expanded the program to nearly 100 projects across 10 industry vertical groups and nine C-suite roles in both the public and private sectors. IBM has been an active member, open to sharing what its teams have learned in their collaborations with Walmart and the Brooklyn Roasting Company on food traceability, with Maersk on digitizing global shipping, and with Unilever on tracking digital ad buying.[2]

The crucible of common experience leads to similar thinking. That's probably why these themes of Jai Singh Arun, Jerry Cuomo, and Nitin Gaur's book, *Blockchain for Business*, resonate so much with our own— and in my view, are spot on.

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2. Reshma Kamath. "Food Traceability on Blockchain: Walmart's Pork and Mango Pilots with IBM." *Journal of the British Blockchain Association* (June 12, 2018). jbba.scholasticahq.com/article/3712-food-traceability-on-blockchain-walmart-s-pork-and-mango-pilots-with-ibm; IBM Corporation and Brooklyn Roasting Company. "Transparency from Farm to Cup." *The Blockchain Bean*, May 1, 2017. www.ibm.com/thought-leadership/blockchainbean; Larry Dignan. "Unilever Aims to Force More Digital Ad Transparency, Plots Blockchain Pilot with IBM." *ZDNet*, February 12, 2018. www.zdnet.com/article/unilever-aims-to-force-more-digital-ad-transparency-plots-blockchain-pilot-with-ibm; Nicky Morris. "Maersk/IBM Complete Supply Chain Blockchain Pilot." *Ledger Insights*, August 9, 2018. www.ledgerinsights.com/maersk-ibm-supply-chain-blockchain-pilot-tradelens.

Digital identity. Jai, Jerry, and Nitin highlight the role of digital identity throughout *Blockchain for Business*. Indeed, Jai is a thought leader in this area, the co-author of one of IBM's important works, "Trust Me: Digital Identity on Blockchain."[3] This is a big deal, and it was a big idea of the paperback edition of *Blockchain Revolution*. Alex and I underscored the need for *self-sovereign identities*, using blockchain as a means of bootstrapping our identities and enforcing them in any context without a third party. We reported on the work of the Decentralized Identity Foundation (DIF), a consortium of which IBM is a member. DIF was formed to combine "decentralized identities, blockchain IDs, and zero-trust data stores that are universally discoverable."[4] Its working groups are focusing on three big areas— identifiers and discovery, storage and computation of data, and attestation and reputation—with an eye toward developing use cases and standards.[5] IBM has contributed a lot to these endeavors, working with ATB Financial, Evernym, the Sovrin Foundation, and Workday on verifiable credentials, and with SecureKey Technologies on a new digital identity and attribute sharing network with a mobile app, among its many collaborations.[6]

Opportunities and challenges. Concerted effort to transform obstacles into opportunities has been the most important factor in the block-chain's success thus far. Executives need to understand the regulatory uncertainty, the level of energy consumed by proof-of-work consensus mechanisms, the efforts of governments such as China and Russia to

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3. Jai S. Arun and Alexander Carmichael. "Trust Me: Digital Identity on Blockchain." IBM Institute for Business Value, April 2017. public.dhe.ibm.com/common/ssi/ecm/gb/en/gbe03823usen/ gbe03823usen-00_GBE03823USEN.pdf

4. Identity.Foundation. "Decentralized Identity Foundation" n.d. identity.foundation.

5. Identity.Foundation. "Working Groups." n.d. identity.foundation/#wgs.

6. Dan Gisolfi. "Decentralized Identity: An Alternative to Password-Based Authentication." *Blockchain Unleashed: IBM Blockchain Blog*. IBM Corporation, October 5, 2018. www.ibm.com/ blogs/blockchain/2018/10/decentralized-identity-an-alternative-to-password-based-authentication; Adam Gunther. "Collaboration: Unlocking Decentralized, Digital Identity Management through Blockchain." *Blockchain Unleashed: IBM Blockchain Blog*. IBM Corporation, April 4, 2018. www. ibm.com/blogs/blockchain/2018/04/collaboration-unlocking-decentralized-digital-identity-manage-ment-through-blockchain.

limit individual use of cryptocurrencies, and the fears that blockchain technology will be a job killer, to name a few areas of concern. We wrote quite a bit about these issues, and we applaud the authors for tackling them head-on.

Business models. The business models for blockchain are largely decentralized networks, subject to network effects such that when the number of nodes increases, so does the size of the business model. Jai, Jerry, and Nitin have described four important business models: founder-led networks, joint ventures, the consortium, and business ecosystems. They outline a four-step process for moving from pilot project to enterprise integration. It's very hands-on.

Governance. The blockchain space is full of formal and informal leaders. Some have executive roles in start-up, blockchain consortia, and regulatory bodies, and others possess vision and talent that are both compelling and influential. We wrote extensively about the need for governance networks—multistakeholder networks in the domains of standards development, policy guidance, community advocacy, knowledge, and education, among others. Jai, Jerry, and Nitin were wise to cast these issues in practical terms of permissioned and permissionless blockchains, with on-chain and off-chain governance of protocols and the applications that run on them. These issues will be critical to the scaling, interoperability, and crisis management of these systems over time.

Team building. Here's where the rubber meets the road in enterprise blockchain pilots. IBM has vast experience in this area, assembling teams across divisions within its own firm and working across industries and national boundaries. The authors provide a guide to getting the right people on the team and then managing the project effectively, so that the enterprise can leverage success and learn from failure.

Financial models. The financial services industry has become somewhat of a Rube Goldberg contraption that performs eight basic functions: verifying identity, transferring payments, holding savings, making loans, trading assets, investing capital, insuring assets and managing risk, and accounting. Smart contracts and distributed applications running on distributed ledgers are challenging incumbents in each of these eight

areas. Initial coin offerings are already disrupting venture capital. Conversely, incumbents could transform their businesses for the better, if they embrace blockchain. IBM is working directly with American International Group on a smart multinational insurance contract for Standard Chartered Bank, and with the Bank of Montreal, CaixaBank, Commerzbank, Erste Group, and UBS on their global trade finance platform called Batavia.[7]

Jai, Jerry, and Nitin have provided a sound blueprint for constructing an enterprise blockchain strategy, from identifying appropriate use cases to driving top-line growth and establishing a competitive position. We agree—now is the time for leaders to act, and *Blockchain for Business* should get them moving.

—Don Tapscott,
Cofounder and Executive Chairman
Blockchain Research Institute
Co-author, Blockchain Revolution

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7. Suzanne Barlyn. "AIG Teams with IBM to Use Blockchain for 'Smart' Insurance Policy." *Reuters*, June 15, 2017. www.reuters.com/article/us-aig-blockchain-insurance-idUSKBN1953CD; Giulio Prisco. "IBM, Five International Banks Pilot Blockchain-Based Platform for Trade Finance." *NASDAQ.com*, April 26, 2018. www.nasdaq.com/article/ibm-five-international-banks-pilot-blockchain-based-platform-for-trade-finance-cm954045.

PREFACE

Because blockchain has the potential to drive the re-imagination of processes and business models in a distributed and decentralized manner, it can be a transformational technology for many businesses. Many business and technology leaders, however, might overlook its potential usage and value for their business and industry, or associate it primarily with Bitcoin and cryptocurrency applications.

Although blockchain is the foundational technology underpinning Bitcoin, it has broad applicability to multiple industry use cases and enables compelling value propositions beyond the financial world. The capabilities of blockchain for enterprise use cases beyond cryptocurrency are not well understood, and the potential for transforming business models in new ways by using blockchain is not obvious for many reasons. A business-driven technology usage perspective requires a balance between pragmatism and a vision for business outcomes.

WHO IS THIS BOOK FOR?

There are many good books available today that address the high-level potential of blockchain technology or go deep into technical

implementation and programming topics. The primary intent of this book, however, is to address the distinct gap between high-level and deep technical concepts.

This book is a practical guide for leaders who need to understand and evaluate how blockchain technology can transform their organizations' business processes and models. It provides a simple and pragmatic over-view of blockchain technology and its capabilities and value from a business perspective. It describes various real-world examples, implementation approaches, and industry-specific and cross-industry use cases. In addition, it provides leaders with the insights that are needed to define potential business models and governance structures, establish teams in decentralized or hybrid enterprises or ecosystems, and understand the costs and return of investment. Also, this book brings clarity to the current state of the technology and its evolution and describes how leaders can better prepare to take advantage of upcoming capabilities.

Many leaders who are still unsure about how to drive transformation with blockchain technology start by identifying a right business use case; defining a business model and governance structure; establishing a team; and determining costs, return on investments, and a financial structure. This book addresses these concerns for business and technology leaders by providing an integrated view of business and blockchain technology.

WHAT IS COVERED IN THIS BOOK?

Our goal is to cover all of the key topics with which you need to be comfortable in order to positively impact your organization as it evaluates and implements blockchain technology. Even if you are already familiar with some of the basics, the early chapters will reinforce your understanding of important concepts and explore general use cases. As you dive deeper, you will be systematically introduced to the specific steps and details that will enable your organization to successfully implement a blockchain solution.

Feel free, however, to jump directly to the chapter that most directly impacts your current role and answers your most immediate questions. You will also find references for further study throughout the chapters to fill in any gaps or provide more detail, depending on your level of experience or organizational role.

CHAPTER 1: INTRODUCTION TO BLOCKCHAIN

The introductory content in Chapter 1 shares critical perspectives of blockchain technology so that leaders can realize its beliefs and gain a true understanding of enterprise blockchain concepts and capabilities. You will learn why blockchain matters for your business. You will learn about trailblazers and key aspects, including how to carefully select a scope for your blockchain project and motivate participants in a blockchain business network while ensuring governance. This chapter also shares some transformational examples of blockchain for social good, and shares "top of the mind" questions and answers that are related to blockchain technology.

CHAPTER 2: OPPORTUNITIES AND CHALLENGES

You might be wondering what opportunities and challenges you might face when you implement a blockchain network. Chapter 2 describes these topics, including how blockchain can apply to your industry and business objectives. It describes how blockchain technology's disruptive elements drive transformation across traditional organizational structures, business models, and ecosystems. These elements also fundamentally open endless opportunities in many industries to innovate and challenge the status quo. The primary challenges for a blockchain project's success are specific to the scope, motivation, and governance, rather than the technology.

CHAPTER 3: UNDERSTANDING THE TECHNOLOGY LANDSCAPE

Chapter 3 defines the overall blockchain technology landscape and addresses the trust divide between an enterprise (permissioned) blockchain and a public, permissionless blockchain. Enterprise blockchain design and enterprise integration impact the cost of the solution deployment and the longevity of the application, so economic incentives are a vital component of any blockchain network. This distinction is vital for the valuation of crypto assets and to ensure the continued and sustained growth of a blockchain-powered business network.

CHAPTER 4: BUSINESS OF BUSINESS MODELS

When you are ready to adopt blockchain into your enterprise, it is important that you pick the correct business and technology model for your business and industry. You want a model that provides economic incentives for joining a blockchain network, such as the creation of value that exceeds what you can achieve alone. The correct model will also help you combat the disruptive forces that blockchain creates, which is imperative if you want to compete under this new economic paradigm. Chapter 4 describes the possible business models that you can choose, which include joint venture, consortium, NewCo, business ecosystem, Build–Own–Operate (BOO) or founder-led networks, and Build–Own–Operate–Transfer (BOOT) or founding consortium–led networks.

CHAPTER 5: DEVELOPING A GOVERNANCE STRUCTURE FOR BLOCKCHAIN NETWORKS

So, you have a model for your blockchain network and are ready to implement it. The first thing you need to do is set up a governance structure, which ensures that you and your ecosystem partners have a common vision and goals for the blockchain network. With a governance structure in place, the ecosystem partners know how their

blockchain network is managed. Chapter 5 describes how to set up the governance structure, which addresses industry-specific requirements and ensures a tight linkage between the business model and the technology blueprint. By adopting a common governance structure, all participants adhere to a common set of objectives, fair and equitable use of network resources, and rules of engagement.

CHAPTER 6: BUILDING A TEAM TO DRIVE BLOCKCHAIN PROJECTS

You must gather many different people to build the team that will drive the creation of your blockchain network. Creating a blockchain project requires enterprise-level roles, such as founders, members, operators, and users, and other roles, such as steering committee members, project managers, blockchain consultants, engineers, and many more. Using "the best of the best" from each enterprise to develop a blockchain network is known as *intraprise synergy*. By using this concept, you empower each participant in the blockchain network with the decentralized authority and autonomy to use their skills as part of the broader network. Chapter 6 describes this concept and its many parts in detail.

CHAPTER 7: UNDERSTANDING FINANCIAL MODELS, INVESTMENT RUBRICS, AND MODEL RISK FRAMEWORKS

As you might have surmised by now, there are many challenges surrounding the technical complexity of blockchain. One such challenge is the plethora of financial models, investment rubrics, and frameworks (structures that aim to scale blockchain networks with the greatest efficiency) that are available today. Which do you choose? Chapter 7 helps you make that choice. By following the guidance in this chapter, you can help ensure a methodical, quantifiable, and measurable deployment of resources while effectively managing risk, all at scale. With the correct mixture of a strategic approach, business design, financial rubric, GRC framework, and

access to technology acumen and the correct talent, a blockchain-powered business network can transform industries and businesses while being disruptive and immensely profitable.

CHAPTER 8: LOOKING AHEAD: WHAT DOES THE FUTURE HOLD?

This chapter prepares you for the future as the evolution of blockchain technology as the network of networks in a decentralized economy becomes more pervasive. You learn about the nexus of the blockchain technology, which includes artificial intelligence, the Internet of Things, and quantum computing, and see how these intersections can add value to your business. Also, this chapter provides readiness advice for critical areas from a futures perspective.

Acknowledgments

It was an inspiring effort to find the gap in the current blockchain books out there in the market, but it was a very challenging task to fill that gap with a truly pragmatic and business value perspective. However, with the collective wisdom and more than seven decades of technology and business leadership experience, a decade of blockchain technology expertise, and thousands of customer interactions among three of us, this expedition was absolutely rewarding and heartening.

Writing a book is a journey, and during this journey there are many people who directly or indirectly help you reach your destination. We are very fortunate and sincerely thankful to have such a supportive, encouraging, and tremendous tribe, consisting of our family members, colleagues, and editing and publishing team members who graciously helped us make this journey successful.

First of all, we sincerely thank the professional and awesome publishing team from Pearson—our executive editor Gregory Doench, a great partner and pleasure to work with who made the entire book writing process very smooth and timely for us; production editor Julie Nahil; copy editor Jill Hobbs; and project manager Rachel Paul.

Second, we are indebted to many of our colleagues who provided exceptional help throughout, including Steven Stansel from IBM marketing services (previously IBM Press), who walked us through with the overall book writing process, reviewed and refined the initial book proposal, and introduced us to the Pearson team; Wade Wallace from the IBM Redbook editing team, our first-gate editor who polished the language, caught grammar inaccuracies, and filled the messaging gaps before handing it over to the Pearson team; Colby Murphy from IBM Blockchain marketing, who helped us with marketing support and specially with the looking ahead and futures content; Tim Richer and Steven Mikolajczak from IBM Blockchain marketing, who provided overall process support to ensure content sanity and adherence to marketing and legal guidelines; Peter Reith from Jerry's team, who helped him with book tasks, timing, and resources; Shaun Lynch from the IBM Blockchain design team, for the creative book cover design; and Steve Kim, also on the IBM Blockchain design team, for design consultation. Our special thanks to Marie Wieck, IBM General Manager, Blockchain, for her kind support, enabling us to work with Pearson on the book and also providing early book review and a review quote. And special thanks as well to Arvind Krishna, SVP Hybrid Cloud and Director of IBM Research, founding leader of IBM Blockchain technology, for his invaluable guidance and leadership in this space and his early book review and review quote.

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and advocacy and working closely with governments, private organiza-
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senior program manager for information privacy and security at Cisco
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their direct and indirect motivation and support.

In the spirit of Jerry famously saying, "Blockchain is a team sport," Jerry
would like to acknowledge Team Cuomo: starting with his lovely wife,
Stephanie; his dad and mom, Jerome/Pop and Rita/Reetz; his daughter

and son-in-law, Rose/Robo and Christophe B.; his son, Gennaro/Bud; his sisters, Stephanie/Ses and Andrea/Agia; and his many wonderful in-laws, aunts, uncles, nieces, nephews, and cousins. Each person has helped shaped Jerry's smile. He thanks the Mind the Gap band (Aydo, Barry, Marc, and Lin) for putting up with practices he missed.

And "Blockchain Jerry" would not be that without his workmates. He knows that by only naming a few, he will get in trouble for leaving people off the list, but he has to, at least, thank the current leadership team of the "IBM chain gang" that supported him in getting blocks on the ledger: Arvind K., Marie W., Bridget Van K., Ramesh G., Brigid M., James W., John McLean, Gari S., Krishna R., Chris F., Sharon C., Anthony O., Kathryn H., Mark P., Peter R., Andy C., Bobbie C., Meeta, Mihir S., David H., Gale F., Steve K., Tim R., Alan D., Alan B., Adam G., Dan G., Eileen L., Rob S., Rachel J., and Michael B. . . . and John W. Jerry has special thanks for Colby Murphy for helping guide his pen in the right direction. Last but not least, Jerry thanks his coauthors, Jai and Nitin, for ensuring that when Jerry agreed to help write this book, it was treated as a transaction on the blockchain that once committed could not be undone. This team has defined Jerry and made him who he is today—and he is so thankful for that.

Nitin would like to acknowledge his wife, Ritu, for her support and for handling things on the home front and taking care of their son, Neil. While jobs and related travel can be extremely demanding on everyone's time, writing a book adds to the ordeal. It is at such times that a nudge and encouragement can do wonders for energy levels, so he thanks both Ritu and Neil for supporting him through this journey.

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About the Authors

Jai Singh Arun is a senior technology business executive driving IBM's artificial intelligence, blockchain, quantum computing, and cybersecurity-related innovations and solutions business strategy, development, and go-to-market execution.

Jai brings over 20 years of technology experience, working with IBM, Unisys, Tata Institute of Fundamental Research, and a start-up, Diablo Technologies. He has a vital mix of business and technology leadership experience with varied functional skills in product management, corporate business strategy, marketing, sales enablement, software engineering and development, customer support for enterprise-class business solutions, and services. He has led many multimillion-dollar new businesses to penetrate into new markets, industries, and segments.

He holds several USPTO-granted patents and inventions published on ip.com. He is also a Certified Information Security Manager (CISM) from ISACA, and a Certified Project Management Professional (PMP) from PMI.

Jai earned his Masters of Business Administration with a concentration in strategy, marketing, and finance from the University of North Carolina (UNC), Chapel Hill; his Master of Engineering degree in computer engineering from Veermata Jijabai Technological Institute (VJTI), University of Mumbai, India; and his Bachelor of Engineering degree in computer science and engineering from National Institute of Technology (NIT), Bhopal, India. He also attended Harvard University executive leadership and management programs.

Jerry Cuomo is recognized as one of the most prolific contributors to IBM's software business, producing products and technologies that have profoundly impacted how the industry conducts commerce over the World Wide Web, while dramatically improving the consumer's experience. Jerry has exhibited a repeating pattern of breakthrough innovations in software design, engineering, and business strategy, across IBM's most financially successful and industry-recognizable software product offerings.

Jerry holds the prestigious title of IBM Fellow, which is the highest technical position at IBM, with only 300 Fellows having been named in the 106 years of IBM's existence. He has pioneered emerging technology projects in the areas of blockchain, API economy, mobile computing, cloud computing, web application servers, integration software, Java, instant messaging software, filing over 60 US patents across these areas.

He is most recognized as one of the founding fathers of WebSphere Software, whose innovations defined WebSphere as the industry-leading application server currently serving over 80,000 customers. WebSphere re-imagines how business, governments, and citizens get work done using the Internet. Jerry's inventions in web server security, performance, scalability, and availability are the reasons why many of the world's most visible institutions are able to securely conduct commerce over the World Wide Web.

Today, as a Vice President of Blockchain Technologies at IBM, Jerry is leading the definition of IBM's blockchain strategy and offerings. Jerry and team have illustrated how blockchain can revolutionize business and redefine companies and economies.

In March 2016 and February 2018, Jerry was called upon by the US House of Representatives to provide expert testimony to US Energy and Commerce Committee on Digital Currency and Blockchain. During his testimony Jerry urged the Obama administration to adopt blockchain as a primary means to protect citizen identity and to enhance national security. His testimony can be seen on YouTube and is often referred to in social media.

Nitin Gaur is an IBM distinguished engineer and worldwide director and leads IBM's global blockchain labs and services. He is responsible for strategy and for developing IBM's digital currency technologies and offerings, such as stable coins and digital fiat. He pioneered IBM's enterprise blockchain strategy and advised IBM decision makers, business partners, and clients on the use of the technology.

1

INTRODUCTION TO BLOCKCHAIN

Blockchain will do for transactions what the Internet did for information.

—Ginni Rometty, CEO, IBM

Blockchain is a technology that is poised to usher in a new way of conducting business that will change everyday life for the better. Blockchain empowers groups of institutions to achieve better outcomes by creating new growth opportunities that together are greater than the feats that any single member could achieve alone.

Blockchain makes it possible to reimagine many of the world's most fundamental business interactions and opens the door to new styles of digital interactions yet to be imagined. It is now regularly showing its potential to vastly reduce the cost and complexity of getting things done across industries, government agencies, and social institutions.

Most people who have heard of blockchain associate it with the cryptocurrency Bitcoin. Although they are related, these two concepts are not the same. The potential uses for blockchain are far broader than the applications for cryptocurrency. Also, whereas the Bitcoin network operates on permissionless membership principles and extends anonymity, a permissioned blockchain network governs its membership with known entities.

The full benefits of blockchain will be realized through its broadest use across the broadest set of industries. We have participated in hundreds of blockchain projects across the supply chain government, healthcare, transportation, insurance, chemicals and petroleum, and many more industries. From those experiences, we have developed three key beliefs.

Blockchain Beliefs

We have the following beliefs about blockchain that reveal its vast promise:

- **Transformative:** We believe that blockchain is a transformative technology that can radically change the way businesses interact. At the center of a blockchain is a shared immutable ledger. Each member of a blockchain network has an exact copy of the ledger that is kept current as it updates over time. After a transaction is entered, it cannot be changed. With this shared copy of the truth:
  - **Net new growth opportunities are discovered** because new trusted business models are identified.
  - **Sustainable competitive advantage is gained** through participation in a new decentralized economy with new business models.
  - **Time is saved** because multiparty transactions can be processed immediately.
  - **Costs are reduced** because overhead is eliminated by having businesses transact directly with each other.
  - **Risk is mitigated** because the ledger acts as an immutable audit trail.
- **Open:** We believe that blockchain must be open to encourage broad adoption, innovation, and interoperability. Organizations such as the Linux Foundation's Hyperledger Project, with hundreds of members across all industries, have provided a breeding ground for business-savvy

blockchain software. Only with openness will blockchain be widely adopted and spur innovation for business.

- **Ready for business:** We believe that blockchain is ready for business use today. A new breed of blockchain technology is now available that has been engineered from the ground up, under the governance of the Hyperledger Project, to handle the demands of enterprises and provide a foundation that ensures good ethical business behavior.

ENTERPRISE BLOCKCHAIN

The basic blockchain concept can be defined quite simply: It is a shared, decentralized, cryptographically secured, and immutable digital ledger. However, *enterprise* blockchain enriches this definition with a few key attributes:

- **Accountability:** Network members are *known* and identified by cryptographic membership keys with assigned access permissions by business role. Without such accountability, compliance with regulations such as the Health Insurance Portability and Accountability Act of 1996 (HIPAA) and General Data Protection Regulation of 2018 (GDPR) would be nearly impossible to achieve.

- **Privacy:** Although members are known to the network, transactions are shared only with those members that need to know about them. Enterprise blockchain uses various techniques to achieve privacy, including peer-to-peer[1] connections, privacy channels,[2] and zero-knowledge proofs.[3]

- **Scalability:** Supporting an immense volume of transactions is critical to enterprise scenarios. Because transactions are not typically throttled in enterprise blockchains as they are in networks like Bitcoin, they can be carried out immediately. Any particular enterprise's transaction rates will depend on many factors, including the number of peers and the complexity of the smart contract. Transaction rates measured in thousands of transactions per second are certainly achievable.[4]

- **Security:** Enterprise blockchains are fault-tolerant. With fault-tolerant consensus algorithms, the network continues to operate even in the presence of bad actors or carelessness. An example of a fault-tolerant consensus algorithm is RAFT.[5]

- **Motivational:** An enterprise blockchain benefits from a built-in incentive system to help accelerate the adoption curve. You can think of this driver as a "loyalty point" or a "token" that delivers a motivational and economic incentive for network providers and consumers.

Enterprise blockchains are often incorrectly characterized as private networks. In reality, access to an enterprise blockchain is controlled by "the governors," who set the policy establishing how new members can participate in the network. The visibility (public or private) of the network depends on how it is governed. Thus, it is true that enterprise blockchains are permissioned, but not necessarily private.

WHY BLOCKCHAIN MATTERS

Blockchain matters because no business operates in isolation. Multiple institutions can achieve more together than any single institution can alone. By implementing business processes that leverage the collective knowledge of the group, processes can become orders of magnitude more cost-efficient. New processes—processes that were not possible before blockchain—can be created. This opens up new opportunities and can create a competitive advantage for many businesses.

For example, the U.S. Food and Drug Administration (FDA) recently adopted food labeling regulations[6] that require manufacturers to notify the public of "sugar added" to food. But how does a company that produces protein bars, for example, know with certainty that the ingredients it is using contain sugar—and more importantly, how can it prove that fact if challenged? When it operates as part of a trusted food blockchain, in which ingredient suppliers record food information to a blockchain, the company marketing the protein bar can easily show the provenance of

each ingredient, from farm to convenience store. This approach saves both time and money.

Additionally, the same blockchain can be used to prevent foodborne illnesses and to enable the participating companies to trace bad ingredients that might be causing such illnesses. Because the food industry must follow numerous regulations (for our own safety and well-being), you can easily imagine how an enterprise blockchain would be essential to making this scenario work. In particular, blockchain can address the following concerns:

- **Accountability:** The blockchain means that you can prove your institution is who you say it is to the FDA and other companies.
- **Privacy:** Your competitor will not know from which vendor you are buying your sugar and at what price.
- **Scalability:** You can track many food records.
- **Security:** You must trust all the information, and information access must be resilient.
- **Motivation:** Economic incentives provide an incentive for members to contribute data.

THE TRAILBLAZERS

The blockchain trailblazers are off to the races, having implemented live networks that are demonstrating real business value today. Consider these examples of early trailblazers:

- The Trade Finance solution[7] that is convened by We.Trade
- The Identity Verification (verified.me)[8] solution that is convened by SecureKey
- The Foreign Currency Exchange[9] solution that is convened by CLS-Group

- The Event Ticketing[10] solution that is convened by True Tickets
- The Autonomous Car[11] solution that is convened by Car eWallet
- The Internet of Loyalty[12] that is convened by Loyyal

These solutions are real, running applications—not proofs-of-concepts. They serve as production systems with multiple members, adding blocks and exchanging value daily.

FOUNDERS

The trailblazers who founded these networks have many things in common. Most notably, behind these solutions you will find a set of imaginative individuals who exemplify the dominant connector archetype.[13] For instance, Greg Wolfond[14] from SecureKey has an inclusive personality and naturally promotes a culture of working together toward a common goal. As a solution convener, Greg has maven and salesman archetype qualities, which instills in others the excitement and motivation to participate in a multi-institutional solution working toward a mantra of "The group can produce a better outcome than any individual institution alone."

By working closely with these solution founders and following trends that are observed from hundreds of blockchain engagements, we have learned what it takes to move an idea to a live network. Specifically, these founders have balanced scope, incentives, and governance to produce a live network.

SCOPE: DREAM LARGE AND ACT INCREMENTALLY

Blockchain solution founders *dream large* and *act incrementally*. They aim to unleash the transformative power of blockchain, but realize that their "moon shot" requires an "Apollo program" that lays out a set of steps that ultimately move the solution to production.

Trailblazing founders agree that the solution scope must be *business-driven*. Most founders set goals that are disruptive, leading to a new way of conducting business. At the same time, their minimal viable product

(*MVP*) goal is more basic, usually focused on demonstrating one facet of the disruptive business model, which is more likely to yield an initial cost savings versus a new revenue stream for solution members. Rather than "ripping and replacing," some founders initially keep their current business-to-business systems in place while they run their distributed ledger technology in parallel to add new functions to an existing business process; in doing so, this approach enriches—rather than replaces—the process. We call this a "shadow ledger."

Similarly, although successful solution founders realize that a decentralized solution is the goal, only a minimal viable ecosystem (*MVE*) of members must participate to launch the solution. Solutions that commence with more members take longer to activate than solutions that start with fewer members. Membership considerations are critical and must be addressed up front. New members might be hesitant to join a network in which their competitors are also participating. However, having competitors participate makes the ecosystem more trusted and vibrant because trust is gained through a diversity of members. The right governance and incentive system can help.

MOTIVATION: DRIVING MOMENTUM WITHIN THE ECOSYSTEM

Successful founders understand how to *motivate the members of their network*. This motivation is often accomplished by creating an economy of buyers (data consumers) and sellers (data providers) within the solution. Motivation is created by balancing obligations and rewards.

For example, the SecureKey solution provides "privacy protecting" ground rules (defined in chaincode) for how data are exchanged. This set of rules also ensures that digital asset providers "get paid" when digital asset consumers "pay" to have identity attributes verified. The ground rules create the backbone of a digital marketplace, which motivates participation through better accuracy, lower-cost verification, greater speed, and a better overall user experience.

Asset tokenization is an emerging technique that is used by enterprise blockchain founders to provide a motivational incentive system. In many cases, the token is native to the solution and can play a role akin to that of loyalty points. For example, one solution introduces a native carbon credit token that is awarded to a network member when that user conserves energy. The user can exchange the token for discounts on debit card purchases that are made via a debit card provider that, like the local energy company, is also a network member.

GOVERNANCE: THE TOTAL IS GREATER THAN THE SUM OF THE PARTS

Governance is mandatory within a blockchain network, and a blockchain solution's likelihood to go live is increased to the degree it is written down. The best founders are "referees" who bring together the group on multiple levels. In each case, a "board of stakeholders" is convened to define the rules that are inherent in the solutions and converge on the scope and motivation.

Workgroups are typically defined to focus on business models, legal concerns regarding intellectual property (IP) rights and liability, technical design, and architecture. Proper business governance encourages participation and removes uncertainty and the risk of business obligations (which are embodied in smart contracts). Proper technical governance ensures that the blockchain solution can be managed in a decentralized way so that deployment of new smart contracts or the invitation of new members happens with consent from the group.

The first graduating class of blockchain trailblazers has already had their solutions go live, with "blocks on the chain." They are dreaming large but starting incrementally, motivating a group of diverse members to participate in a solution through incentives and an inclusive governance process.

BLOCKCHAIN FOR GOOD

The trust model that underlies blockchain networks provides a natural setting for solutions that are unmatched in delivering social good. Blockchain is poised to deliver strong business returns. Moreover, when used correctly, it can deliver user experiences that are respectful of user privacy and literally save lives.

Here are three examples that illustrate how blockchain for social good is also good for business.

REDUCING FOODBORNE ILLNESSES

Has this ever happened to you? You are rushing through New York's LaGuardia Airport trying to make a flight. You are hungry and grab a salad before hopping on the plane. An hour into the flight, though, you do not feel well.

In 2006, a nationwide outbreak of *Escherichia coli*[15] was linked to bagged spinach. It took regulators two weeks to conduct the backtrace and determine the exact source of the outbreak. During those two weeks, many people got sick and one person died. Tons of good spinach was unnecessarily discarded—wrongfully wasted—because we could not tell the good spinach from the bad.

IBM Food Trust Network[16] consists of several major food companies, including Walmart, Unilever, and Nestlé. This network enables supply chain visibility across these members (and their ecosystem) to quickly pinpoint the sources of contamination. The network is already showing results that can reduce the impact of food recalls and limit the number of people who get sick or die from foodborne illnesses.

With blockchain, network members can track the provenance of ingredients as they travel from farm to fork. Recently, Walmart did an experiment that traced the origin of sliced mangos from Walmart stores back to the farm.

This process showed a radical improvement from the approximately 7 days it took to conduct the backtrace by using traditional methods down to 2.2 seconds by using an enterprise blockchain platform. Frank Yiannas, Vice President for Food Safety at Walmart,[17] says, "That's food traceability at the speed of thought with blockchain." This is an inspiring example of blockchain changing everyday life.

ELIMINATING BIG DATA BREACHES

Has this ever happened to you? You are renting an apartment. The real estate company asks you to share information about every aspect of your life—where you live, your mother's maiden name, your Social Security number, your place of employment, and a credit statement from your bank. You repeat this process when you sign up for a new smartphone and when you visit the doctor for a checkup. You have bits and pieces of information, including user IDs and passwords, scattered all over the Internet. Then, you get a notice from a major service provider that your data were stolen! This scenario is scary and frustrating—and all too realistic: An estimated 15.4 million consumers were hit with identity theft in 2016, according to a Javelin Strategy & Research 2017 Identity Fraud Study.[18]

The days of big data breaches appear to be numbered, though, with the emergence of the Verified.Me network created by SecureKey.[8] The Canadian Verified.me network is live and hosted by the major banks of Canada. With the Verified.me smartphone app, you can take control of your digital identity attributes. The app provides a simple experience for signing up for (and signing in to) Internet-based services. Acting as a digital rights management system for your identity, the app enables you to give permission to the real estate company to electronically ask the questions that are required to rent an apartment. Similarly, you give permission to trusted institutions (such as banks, state or province motor vehicle departments, and your employer) to answer the real estate application questions.

With blockchain, the verification process takes place in real time and with unprecedented respect for your privacy. The solution is designed so that

there is no central database of identity information. Instead, the blockchain ledger is used as a digital rights management system, storing permissions and proofs by which the user grants institutions rights to access your identity information. Without a central "data honeypot," the attack surface of an identity breach is radically changed, making it difficult for bad actors to walk away with a "big score."

Blockchain also prevents your digital data from being tracked. You might not want the real estate company to know with which bank you do business. With "triple blind data exchanges," the data requester never knows who the provider is, the data provider does not know the requester, and the network operator knows neither of those parties.

Blockchain enables only the necessary information to be exchanged. If you are using Verified.me to prove your age to enter a bar, you must prove only that your age is 21 or older; you need not show your driver's license, which also includes your address. The National Institute of Standards and Technology,[19] along with other privacy agencies, views this approach as the best strategy for protecting users' privacy.

PREVENTING COUNTERFEITING

Has this ever happened to you? It certainly happened to one of the authors. A friend, who had a headache, asked for an aspirin. I went into the road-warrior aspirin bottle that I keep in my notebook bag and gave him one. Before he took it, he scrutinized the pill and asked, "What are you giving me?" It didn't look like any aspirin he had ever seen. I said, "I think it's an aspirin." He responded with a bit of terror in his voice, "You THINK?" The pill had a number on the side, which I quickly searched on my phone and revealed to be a generic form of Tylenol. Phew!

This sort of issue is rapidly becoming a widespread concern. The World Health Organization estimates that 1 in 10 medical products now circulating in low- and middle-income countries is either substandard or falsified, including pills, vaccines, and diagnostic kits. Examples include cough

syrups for children that contain powerful opioids, and fake antimalarial pills made of only potato and cornstarch.

The Crypto Anchor Verifier project[20] from IBM Research Lab aims to use artificial intelligence (AI) technology with blockchain to prevent counterfeiting. The technology uniquely identifies a physical asset as a corresponding digital asset to trace provenance. The manufacturer can place a digital cryptographic fingerprint of an aspirin on a blockchain so that the pill can be verified for authenticity as it progresses across the supply chain.

The Crypto Anchor Verifier provides a lens attachment for a standard smartphone. This app leverages AI technology to perform light spectral analysis against a physical asset. It captures microscopic properties, viscosity, and other identifiers, and produces a unique digital identifier for physical goods. When immutably placed on a blockchain, the "fingerprint" of that digital good can be checked again by the Crypto Anchor Verifier at customs, at a point of purchase, or immediately before you swallow your medication.

These examples show the promise of blockchain. It is energizing to see blockchain changing everyday life for social good. With this benefit as a motivation, we continue to solve the business and technical problems that will unleash many similarly inspiring uses of an enterprise blockchain.[21]

Blockchain Questions from Business and Technology Leaders

Blockchain is both a disruptive technology and a transformational one. As you think about leveraging blockchain for your business, you might have several questions in mind. As we have shared the blockchain technology and its business value with hundreds of business and technology leaders from many different industries, a predominant set of questions emerged. We did our research and rounded up the most searched terms

as they relate to blockchain for business. Figure 1.1 shows these terms and their associated volume of interest.

Figure 1.1 Most searched blockchain for business terms.

After observing the data from our study, we inferred the top six questions that business leaders might have about blockchain. Each of these questions is introduced here and explored in further detail throughout the rest of this book.

DOES BLOCKCHAIN APPLY TO MY INDUSTRY AND BUSINESS OBJECTIVES?

Blockchain will most certainly impact every industry, including yours. In many cases, blockchain solutions will affect specific industries and cross-industries. For example, the trade, financial, and food-supply industries already are connected by blockchain. Blockchain will transform the way many industries do business, but it will not be the answer for every business objective.

How Does Blockchain Drive Top-Line Growth and Competitive Advantage for My Business?

As blockchain enables trust and transparency across businesses, it opens up new opportunities for new business models, new ecosystems, and new economic environments with secure, distributed business transactions. These new opportunities will drive new revenue streams for many businesses and enable them to leapfrog the competition by adopting a transformational technology and potentially disrupting some competitors from the value chain. For example, a digital trade chain can simplify a trade finance platform and provide access to more trading partners and more business, and a "know your customer" (KYC) application can use blockchain to reduce the friction and time to verify and onboard clients faster.

What Value-Added Business Models Does Blockchain Present?

Blockchain will both enhance many existing business models and create new models. To ensure that we have defined a clear path to enterprise blockchain adoption, we must focus on both business and technology models. We can take a singular use case that has an industry and enterprise impact and apply business and technology value analysis that results in a business architecture and technology blueprint, along with requirements for compliance, audit, and enterprise integration. The aforementioned artifacts drive an adoption model that enlists and surfaces hurdles and challenges, and factors in the costs and economic viability of the blockchain solution. Permissioned networks might also need to uncover the correct incentive and economic model to compel enterprises to join a platform that uses the notion of creation, distribution, and sharing of rewards that benefit all stakeholders. It is imperative that industries start the journey to explore the correct business model that enables value creation and elevates the modernization efforts that many industries desperately need to combat disruptive forces.

How Does Blockchain Network Governance and Design Work?

When members join a blockchain network, there must be clear protocols in place to govern and operate the network. In the enterprise space, we must define a simplified governance framework, in which we create a governance model that is inclusive of the principles of game theories, incentives, penalties, flexibility, delegation, and network mechanisms of coordination. These core principles must be included in all governing aspects of a blockchain business network, including the technology infrastructure governance, network membership governance, and business network governance.

Do I Need a Dedicated Blockchain Development Team?

In short, the answer to this question is yes—but you do not necessarily need a new team. Any developer can be a blockchain developer, because a typical blockchain solution is composed of 80% application and 20% blockchain framework. Applications can be written in languages that your development team already knows, such as Node.js, Go, Java, JavaScript, and Python. The framework component can be managed by blockchain platforms. Like the application component, the associated smart contracts can be developed in familiar programming languages. Therefore, a development team whose members use the knowledge that they already have can easily become a blockchain development team, with 80% of the team focused on the application and 20% of the team focused on the framework.

What Is the Cost of Implementing Blockchain?

The cost of implementing blockchain can be calculated by using variables that are specific to your project or use case, participants, technology, business model, and return on investment (ROI) expectations. However, getting started on your blockchain journey is cost-efficient because blockchain platforms such as Hyperledger, Ethereum, Corda, and Quorum are

open technologies or open source, and even enterprise platforms like IBM Blockchain offer free tiers to help you get started.

OTHER QUESTIONS

Here are some other questions that might be of interest as ponder enterprise blockchain. All these questions will be covered as you continue through this book.

- What are the advantages of adopting blockchain?
- What are the top challenges in implementing blockchain?
- Are there guides to help with implementing blockchain?
- Which scalability concerns arise with blockchain?
- Which type of IT infrastructure is needed to implement blockchain?
- How do I think about designing a blockchain solution?
- Which speed and data acceleration factors must be addressed to meet transactional requests?

CHAPTER SUMMARY

We hope that this introductory chapter has piqued your curiosity about blockchain and its enormous benefits. Imagine a world where your data are secure, fewer people die due to foodborne illnesses, and counterfeiting is a worthless endeavor due to the instant verification of fakes—to name just a few of the benefits of blockchain.

If these benefits are not enough for you, think about how your business can benefit from showing accountability to governments and other entities, safeguarding its business moves while remaining efficient, scaling the enterprise to new levels, keeping its data accessible while also keeping it secure, and profiting from contributing data to the blockchain network.

If this sounds amazing to you and you are eager to learn more about the opportunities that are provided by a blockchain network, continue with

Chapter 2. It explores more of the opportunities that blockchain can create for your enterprise, but also highlights some of the challenges that you must overcome to reap its copious and profitable benefits.

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2

OPPORTUNITIES AND CHALLENGES

Trust is the most important element that drives both a successful transaction in a business and a meaningful personal or social value exchange in a society.

—Jai Singh Arun

Aside from the Internet, which actually emerged at the end of the 20th century, blockchain is the most disruptive technology of the 21st century. It radically unravels the trust, transparency, and accountability issues in business, and opens endless opportunities for innovation across industries.

In recent decades, businesses and trade have crossed geographic boundaries and become global and open in many ways. Nevertheless, the most fundamental challenge remains trust. In many situations, would-be partners have either limited or no trust, which is why an intermediary is often required between two or more parties to complete their business transactions. Examples of such intermediaries are banks, insurance agencies, trade agencies, government agencies, credit agencies, and identity bureaus.

The transformational shift that blockchain delivers is a new way to forge trust among distrusted partners. This shift will disrupt the way that they—and you—do business. It brings many new opportunities and a

shared or peer-to-peer economy for every industry and organization, including intermediaries, to reimagine and transform their business processes and business models. However, every opportunity comes with an initial challenge. Blockchain adoption is challenging when you try to address too large a scope, there are no motivations or incentives for participants, and the governance structure is cumbersome and has many stakeholders.

DISRUPTIVE ELEMENTS

What makes blockchain so disruptive? Blockchain intrinsically bridges the trust gap in our business networks and our societies by co-developing a shared copy of the truth. Five critical elements of the blockchain technology drive this disruption: transparency, immutability, security, consensus, and smart contracts (Figure 2.1). How you see these disruptive elements—that is, your perspective of each of them—suggests ways to transform your business.
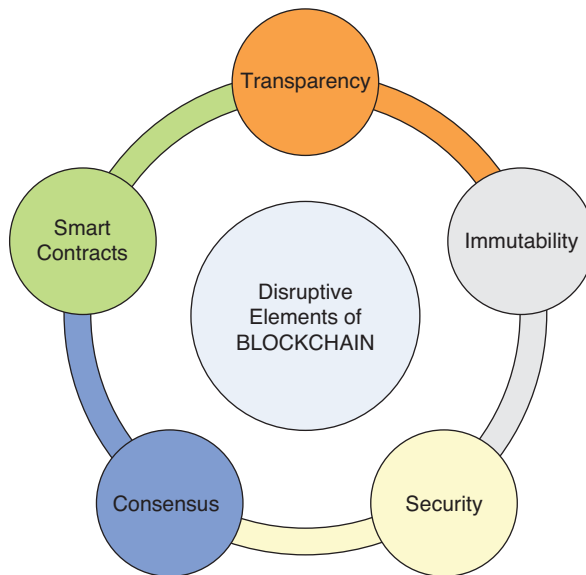
Figure 2.1 The five disruptive elements of blockchain technology.

TRANSPARENCY

Blockchain provides end-to-end visibility of your business transactions with a single source of truth that is replicated or shared across the distributed ledger in your business network. Based on the permissions that are given in a private or public blockchain-based business network, you can see the full trail of a transaction. In the past, this transparency has not existed in business networks that involve multiple participants. Thus, the new transparency disrupts many intermediaries or third parties in your business network by enabling direct peer-to-peer connection and exchange.

Imagine a supply chain network with a single source of truth across the value chain.

It is difficult to get real-time visibility of shipments in a logistics and supply-chain business because such a complex network includes multiple participants (users of goods, retailers, distributors, manufacturers, suppliers, and brokers), each of which keeps its own record of a transaction, and whose records are never synchronized. A blockchain-based supply chain network provides greater visibility and transparency that drives efficiency and higher value.

IMMUTABILITY

After you record a transaction into a blockchain, no one can delete it. If you try to modify the transaction, the blockchain appends another update record to the transaction, which is visible to the participants in the network. Each transaction in a blockchain is encoded into a data block and uniquely signed and timestamped. Each block is connected to the blocks before and after it. These blocks cannot be altered or modified; they are linked together to form a chain that is immutable and irreversible. An immutable history of transactions eliminates the counterfeiting and fraud challenges faced by many businesses.

The blockchain-driven provenance process eradicates counterfeiting by using immutability and transparency.

Counterfeiting is the biggest challenge globally for legal and financial documents and valuable goods, such as drugs, food products, luxury clothes, and jewelry. It costs companies more than 7 percent of their annual expenditures, amounting to almost $4 trillion each year on a global scale.[1] The immutable digital record and history of transfer of an asset or good are identifiable and visible to the participants within the blockchain network, so this approach blocks fraud and tampering attempts in a system or process.

SECURITY

Blockchain provides a highly secure transaction system that is almost impossible to hack. Every transaction record on a blockchain is cryptographically secured with digital signatures, along with a trail of the transaction updates. Participants in the network have their own private keys that are assigned to a transaction or any update to an existing transaction. Therefore, security vulnerabilities are easily identified and inherently prevented. Every transaction is replicated or shared across the distributed ledger, which means that hackers must look at every ledger and find the same data or record across all the ledgers, which is difficult.

Security, privacy, and compliance are bolstered by a distributed ledger, transaction integrity, high availability, and auditability.

The security of business-critical data and transactions is a primary concern in any organization and across all industries. Digital transformation of such data and transactions, in turn, is the key driving force of further complexity in today's business world and brings up new security issues. Global cybersecurity spending was expected to exceed $114 billion in 2018, according to analyst firm Gartner,[2] and Statista predicts that it will total more than $234 billion by 2022.[3]

Most organizations keep their business and customer information in a centralized system. Unfortunately, such centralized systems are vulnerable to attack. Blockchain applies a decentralized approach, in which the transaction data are replicated across the distributed ledger. Thus, even though one of the ledgers is not active, the other ledgers have a copy of the transactions and ensure availability. Each transaction is validated or consented to by network participants before it is posted in the ledger. Although you can identify the members in a blockchain, they can maintain their anonymity and privacy, which is important for organizations to ensure trust. Having an untampered transaction history in blockchain delivers readily available auditability for compliance and regulation purposes.

CONSENSUS

The network participants in blockchain use a consensus mechanism to eliminate the need to rely on central authorities and third parties to validate business transactions. The foundation of cryptocurrency, for example, is a public blockchain that requires miners to validate the currency transactions. This process, which is called *proof of work* or *mining overhead*, involves a huge amount of computing power and energy. In contrast, permissioned blockchain includes trusted participants on the network and uses consensus algorithms that validate transactions anonymously without mining overhead, and with a fraction of the computing power and the energy costs that are used in a public blockchain.

Consensus drives fair participation in a business network with democracy.

On a global scale, unfairness is more than 50% in economic structures where benefits and burdens are not fairly distributed across the country government according to a BBC poll. Many businesses spend billions of

dollars every year to deal with unfairness issues, while others lose billions of dollars every year without being aware of unfairness. Many intermediaries in the legal, business, and government arenas take advantage of unfairness and deceptive practices for their own economic or financial benefits. Blockchain technology has the potential to replace the unfairness in government and businesses with a truly democratic and transparent approach toward transactions.

SMART CONTRACTS

You can think of smart contracts as self-executing electronic contracts that state the legal and business terms of an agreement between business partners. Smart contracts in blockchain are business logics that are programmed and embedded into a transaction record that enable business process automation. Such contracts allow transactions and agreements to be executed among various business participants without engaging the services of a central authority, legal system, or arbitrator. Business process automation is possible by using smart contracts because the transactions in blockchain are trusted, transparent, and immutable.

Smart contracts fuel business process innovation with automation, speed, and compliance without hefty costs and risks.

Even though automation and agility are increasing in business or legal contracts management, the average cost of processing and reviewing a basic contract has increased by 38 percent in the last six years and now averages $6900, according to the International Association for Contract and Commercial Management (IACCM).[4] The global legal services market alone is expected to top $1 trillion by 2021, based on a Statista report.[5] Think how much you are spending on your contract management services and how much potential smart contracts have to save money, enable contracts to be processed faster or almost instantaneously electronically, and reduce risks through application of transparency and immutability. Initial

estimates suggest that blockchain technology can reduce the execution time of business contracts from days to minutes, from manual to automated, at a fraction of the current cost, essentially without any legal entity becoming involved.

Next, we'll explore how these disruptive elements from blockchain can uncover new opportunities for your business's transformation.

OPPORTUNITIES

Many individuals and organizations (sometimes unintentionally) thwart positive changes in business due to their inability to see how new innovative technologies can revolutionize the future. Emerging technologies bring new opportunities and change our lives by changing the way that we think and operate. Two of the revolutionary technologies that we witnessed in the 20th century were personal computers and the Internet. The next significant transformative technology of the 21st century is blockchain.

Gartner forecasts that the business value that is driven by blockchain will amount to $3.1 trillion by 2030.[6] The true business value will be driven by the new opportunities that users envision to transform their businesses in various use cases across a wide range of industries, from cryptocurrency to cross-border payments, food safety to provenance, supply chain to trade finance, clinical trials to healthcare exchanges, digital rights management to royalty settlements, digital identity to land registry, and many more. Blockchain presents endless opportunities.

TRANSFORMATIVE POWER OF BLOCKCHAIN

Blockchain technology drives transformational opportunities in three ways so that enterprises, economies, and ecosystems flourish. This transformation trilogy is composed of new organizational structures, new business models, and new ecosystems (Figure 2.2).
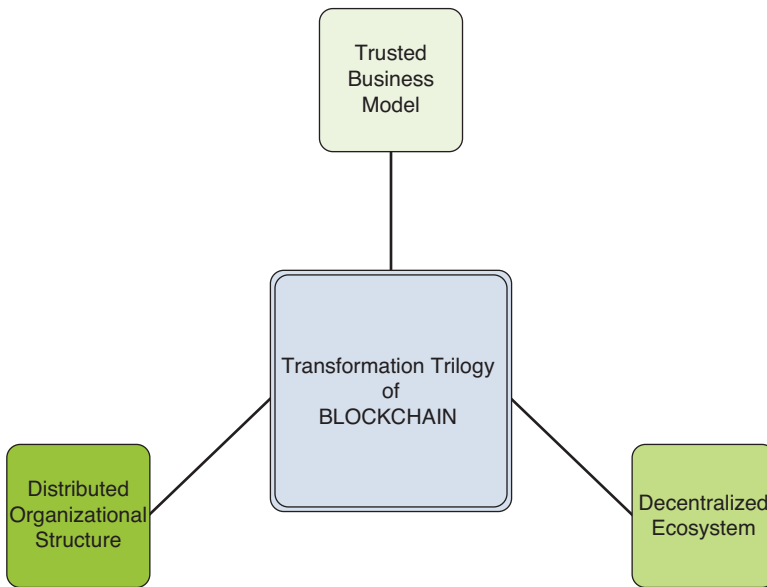
Figure 2.2 The blockchain transformation trilogy.

Distributed Organizational Structure

Most modern organizations, whether public or private, are highly central-ized, and they typically institute bureaucratic governance that benefits monopolies. Partners in that network are driven to compete adversely. All too frequently, a command-and-control–driven approach intended to gain short-term benefits disables the innovation agenda in these organizations. The centralized structure in such an organization has either limited or no visibility, trust, and transparency across the business. These challenges drive higher costs, reduce agility, add inefficiency in operations, and create an unhealthy and unsustainable culture within the economy.

Now imagine how you might use blockchain to revive a centralized organi-zational structure that drives freedom of innovation and autonomy in the participating business networks. The distributed nature of blockchain technology, along with the emphasis on consensus and smart contracts, delivers a self-governing business network with a greater autonomy that

flattens traditional enterprise structures into a distributed and shared structure. Business transactions are managed in a distributed and shared ledger that offers transparency and visibility across the network without any complex and hierarchical nature. Imagine a new government structure for a country that is free from fraud and bureaucracy and transparent to its citizens.

This new distributed structure enables organizations to be highly cost-effective, efficient, and faster in delivering services and business results.

Trusted Business Model

Business models are primarily a construct indicating how organizations bring a set of capabilities to create and deliver value to their clients and partners by maintaining relationships, ensuring stickiness, and differentiating products and services from those of their competitors. The traditional business models are process-heavy and require the presence of many stakeholders, intermediaries, and third parties due to limited trust and transparency. These characteristics drive inefficiencies, higher costs, and sluggishness in the business. Recently, however, new models have emerged that have disrupted traditional models, such Uber (taxi service), Airbnb (short-term housing rental), and Netflix (movie rental).

Blockchain presents many opportunities beyond cryptocurrency for organizations to disrupt traditional business models by using peer-to-peer exchange with trust, digital and automated execution of business contracts, and agreements with smart contracts. The intermediation between third parties is handled by distributed ledger and transparency, and transaction integrity is ensured with security and cryptography.

Blockchain injects trust into business transactions. It fundamentally changes the state of trust in business models by making it dynamic, so that business models can be defined as either trusted, semi-trusted, or untrusted. A public, private, permissioned, or consortia blockchain establishes trust with the correct governance structure and policy.

Organizations' brand and reputation systems that are built on blockchain can provide assurance of truth and transparency through their business records, which can visibly demonstrate trustworthiness to their potential clients and partners.

Examples of such business model transformations include the following:

- A music distribution model in which music files are exchanged directly from creator to the listeners and monetized without any distributors
- A remittance model in which money is transferred from a sender to a receiver without a financial institution acting as an intermediary
- An open market model that connects buyers and sellers directly without an exchange intermediary

Decentralized Ecosystem

An open approach toward business transactions' trust and transparency in a network that is driven by blockchain promotes a transformational journey for the network's participants. In this approach, organizations and systems cooperate, and value is co-created and contained in the network.

As blockchain delivers distributed organizational structures and trusted business models, it fosters new emerging trusted marketplaces and economy-to-exchange value. Peer-to-peer models are driving the new ecosystem of players and eliminated the roles for intermediaries. This systematic change fosters the creation of new consumers, competitors, microeconomies, profit pools, and a distributed ecosystem. Decentralized, ecosystem-driven markets are impossible to compete with.

The following examples illustrate new ecosystems that can emerge as part of distributed environments:

- Start-up funding is reinvented by using initial coin offerings (ICO) and tokens.

- A "know your customers" (KYC) service is created and used within a business network and eliminates the traditional KYC that was redundant for each organization.
- Assets and land registration in developing nations can leapfrog traditional rural and urban development and real estate governance ecosystems in developed nations.
- A trading and investment model runs without a clearinghouse.

Achieving these kinds of advances is not a matter of mastering the blockchain technology; instead, it requires rethinking your current market role, value streams, and existing business ecosystems, and finding opportunities to transform your business. This is a new radical shift in businesses in which many elements must be redesigned, such as organizational structure, business model, and ecosystem.

TRANSFORMATIVE OPPORTUNITIES

This section examines some of the industry-specific transformational opportunities that may be driven by blockchain, beyond Bitcoin or cryptocurrency.

Banking and Financial Markets

Blockchain capabilities deliver banking innovations to revamp the experience for customers by reducing transaction times from hours to seconds, eliminating manual processes, and eradicating unnecessary intermediaries in trade finance, digital identities, and cross-border payments. With blockchain, you can conduct business rapidly and securely, moving from paper-based to blockchain-stored transaction records, which can enable easier expansion to underserved markets, such as small and medium enterprises.

Trade Finance

Banks continue to struggle with manual processes and stringent requirements for managing, tracking, and securing domestic and cross-border trade transactions. For example, processes for corporate trade financing

letters of credit are typically paper based and fragmented, which can make financing more challenging for the 50 percent of smaller enterprises that might not have credit sources.

Blockchain-based smart contracts can automatically store, secure, and exchange contract details and financial terms; coordinate trade logistics and payments via an integrated real-time network; and streamline digital trade processes. With blockchain, ledger transactions can flow from one small enterprise to another one through a trusted bank. Larger firms can also benefit by better tracking of trade finance transactions.

For example, IBM and eight European banks have created We.Trade, which is a multiple-bank collaboration that is building trusted digital trade chain connections with smaller enterprises.

Digital Identity Verification

Requiring clients to repeatedly provide identifying information can erode customer satisfaction and cause transaction delays. Onboarding clients for checking accounts or mortgages or migrating them from one bank to another requires strict compliance with KYC standards.

On IBM Blockchain, identification documentation can be consolidated with managed access and permissions without storing the actual identifying information. This supports KYC due diligence, helps secure personal information, and enhances client satisfaction.

For example, IBM and SecureKey Technologies are building an identity-sharing ecosystem with Canadian banks that will enable clients to instantly verify identities when opening new accounts. Other uses include driver's license applications and requests for utility services.

Insurance

Blockchain can simplify and secure multiparty operations at the heart of the insurance industry. Whether interacting with customers or dealing

with other parties, blockchain can reduce the challenges that are presented by multiple parties that keep their own records.

As transactions occur, insurers can rely on blockchain's distributed ledger technology to update and validate information against other records in the network; reduce management costs for policies, claims, and relationships; streamline operations; and enhance customer satisfaction. Companies can also capture opportunities and revenue through new business models or new insurance products.

Complex Risk Coverage

Employees, policy holders, adjusters, and agents who cannot view insurance policy information usually need human help, which increases the chance of errors, delays claims resolution, and increases costs. The challenge escalates with complex insurance programs or managing policies in multiple countries, which can involve strict legal and regulatory adherence. Blockchain can resolve many of these obstacles to smooth operations.

For example, using IBM Blockchain, AIG and Standard Chartered converted multiple policies into "smart contracts" that provided a single, consolidated view of policy data and documentation in real time. The solution enables visibility into coverage and premium payments, delivering automated notifications to network participants after payment events occur.

Group Benefits

Organizations offering group benefits often rely on a complex network of administrators, providers, employees, and others to manage those benefits. Different versions of the same data require consolidation to ensure eligibility and access to benefits.

For example, IBM Blockchain can be the vital link across a vast ecosystem of third-party administrators and service provider networks. Its shared ledger transparency can help employers reduce errors, which results in

improved claims processing, better provider management, and lower operational expenses.

Healthcare

Blockchain can transform healthcare enterprises and increase the quality of care by enabling new ecosystems and new business models to evolve. Healthcare information that is stored on a blockchain can change the way that providers store clinical information and how they share information within their own organization as well as with other healthcare partners, payers, and patients.

Blockchain decentralizes healthcare information, increasing data availability, efficiency, transparency, and trust. However, it requires careful planning to make the most of the advantages it brings. The blockchain infrastructure that IBM is helping to build provides enterprises with a solid platform for both immediate and long-term business solutions.

Patient Consent and Health Data Exchange

Disparate record-keeping systems can result in patient consent forms and medical histories that are incomplete, conflicting, or ambiguous. By comparison, blockchain-stored records can be used to provide complete, longitudinal health records for individuals, giving all patients more control over their own information through verifiable consent. With blockchain, every patient record reflects the best-known medical facts, from genomics data to diagnostic medical imaging, and data can be reliably transferred when needed, with no need for a central gatekeeper.

Clinical Trials Management

Clinical trials of healthcare interventions generate mountains of data, which requires healthcare administrators to keep reliable and consistent records for peer review and to meet regulatory requirements. Blockchain tools, in concert with electronic data capture (EDC), allows clinical data to be automatically aggregated, replicated, and distributed among

researchers and practitioners with greater auditability, provenance tracking, and control compared to complicated conventional systems.

Retail and Consumer Goods

Blockchain is removing obstacles and increasing visibility for consumer products and retail business transactions. Greater transparency through a shared and immutable ledger enables businesses to establish a climate of trust across areas such as invoicing and payments, the consumer supply chain, and global shipping. Through the use of a distributed and trusted database, a blockchain solution reduces barriers that might otherwise impede business, such as siloed management and regulatory systems, time-consuming settlement processes, and uncertainty between entities conducting transactions.

Blockchain speeds transactions, builds trust between participating members, and opens the door to cross-industry and global business opportunities.

Commerce

All too often, lengthy invoicing and payment processes across diverse systems lead to delays in verification and payments, triggering disputes and driving up the cost of doing business in today's global markets. Blockchain helps remove friction from such commerce by providing a common chain of information visibility that is shared across vendors and purchasers.

For example, a major consumer goods company used IBM Blockchain to reduce the complexity and ambiguity it encountered in invoice processing. The solution cut processing times from five days to one and trimmed processing costs by 50 percent. The company plans to expand its new model to numerous other supplier relationships.

Supply Chain Management

Disparate systems that are used by multiple entities across a supply chain can block visibility across the ecosystem, creating an atmosphere of distrust and leaving all parties at risk. For example, trust in the food supply has suffered due to a lack of industry transparency between suppliers, processors, distributors, retailers, logistics providers, and consumers.

A blockchain-based food supply chain provenance like IBM Food Trust is a collaborative solution that unites growers, distributors, processors, retailers, and other food industry stakeholders to efficiently and securely trace food through every step of the supply chain. The IBM Blockchain–powered solution helps ensure food safety from farm to store through rapid end-to-end traceability of data and access to compliance certification.

For example, Walmart and IBM have partnered to help improve food safety by using IBM Food Trust. The first blockchain food safety solution to run production data for products across the food system, it allows early adopters to confidently and securely share data with their food supply chain partners.

In another supply-chain application, IBM and Maersk have announced a joint effort to streamline shipping through creation of an efficient and secure global trade digitization platform based on IBM Blockchain. The proposed venture will address needs for transparency, simplicity, and open standards as goods move across borders and trading zones.

Government

From issuing identification and registering property to administering elections and enforcing laws, government must ensure stringent data stewardship to protect citizen information, maintain trust, and ensure the accuracy of public records. Governments face challenges unlike those encountered in any other domain: Data architects, administrators, and privacy officers must protect citizens' personal information, yet keep vital

information accessible when needed. Scaling complicates life for government administrators, too: The vast scope of mandated services and the large workforces that are needed to provide them can lead to fraud, waste, and abuse, allowing significant errors to slip into vital public records.

Asset Registration

We rely on government to accurately record and track our homes, businesses, cars, and more, so as to verify ownership and ensure smooth financial transactions. Accurate and accessible registries are crucial to engender trust and transparency in government. Despite this need, today's registries suffer from slow, duplicative processes and an overreliance on error-prone, incomplete, and manual data entry. Blockchain enables government agencies to increase the accuracy and efficiency of publicly held records by linking ownership of an asset to a single and shared ledger without disrupting the existing registry data.

Fraud Prevention and Compliance

All too often, fraud, information privacy abuse, and accidental data exposure plague government data transactions. Moreover, siloed legacy systems and processes within government frequently result in multiple versions of multiuser data sets. In the absence of a single version of the truth, the risk of fraud and the difficulty of ensuring compliance increases each time a data set is accessed, because there is no way to distinguish between correct and incorrect entries.

Blockchain creates a shared and trusted ledger that sequentially appends cryptographically secure data. This ledger is accessible only to trusted parties, giving government administrators the assurance that they are working with data that are up-to-date, accurate, and nearly impossible to manipulate.

Media and Entertainment

Blockchain is increasing transparency in digital transactions and removing complexity from the media and entertainment ecosystem by reducing the

need for multiple stakeholders in advertising purchases and digital content management. With an immutable and shared ledger that records transactions as they occur, companies in media, advertising, entertainment, and others have complete visibility as content or data are purchased and used.

Blockchain is designed to accelerate the creation of "built for business" global blockchain networks across industries and use cases. The implications for media and entertainment can be profound, such as in digital rights management—trusted and transparent content distribution in a digital ecosystem.

Advertisement Settlement

Nearly 50 percent of ads fail to reach their intended audience.[7] Moreover, antiquated rating and measurement systems can make it impossible to know the precise number of audience impressions achieved with a specific ad. Digital advertising fraud costs at least $7 billion annually,[8] while intermediaries profit from 60 percent of ad spending. Discrepancies in systems of record typically lead to disputes, labor costs, leakage, and poor cash flow.

Using an immutable blockchain ledger can remove the need for intermediaries, thereby reducing advertising costs. By digitally recording transactions across the advertising ecosystem, advertisers, intermediaries, and advertising sellers have a shared knowledge of impressions and can use smart contracts to create a transparent system that proves spending is based on actual impressions. Inventory management can be streamlined, and billing and invoicing can become more efficient for agencies creating ads.

For example, Unilever, one of the world's largest advertisers, partnered with IBM to build a blockchain solution to manage its advertising supply chain and create a trust-based and transparent solution that enables buyer verification, offering a way for all parties to visualize every part of the advertising process. The new transparency will make it easier for

advertisers and advertising platforms to know how efficient campaigns are, justifying (or not) advertising expenses.

Loyalty Programs

Loyalty programs have been implemented in a variety of forums, spanning the hospitality, finance, entertainment, airline, and retail industries, among others. However, segmented systems can make it impossible for consumers to exchange their loyalty points across entities, including ones in the same industry, such as banks. This situation limits cross-marketing and revenue growth opportunities.

Blockchain solutions make it possible to provide complete visibility into a loyalty inventory to establish trust across the loyalty ecosystem, enabling, for example, a consumer to book a hotel, purchase a theme park ticket, or buy a cup of coffee by using frequent-flyer points. Conversely, the consumer can gain credit through loyalty points that are earned with other entities and use them with the airline.

For example, China UnionPay, which guarantees credit card usage across Chinese banks in more than 150 countries, uses IBM Blockchain to help bank customers exchange bonus points that are earned through purchases among disparate banks. The new peer-to-peer bank reward point trading system will allow points exchange between banks, credit card users, and gift shops.

Automotive

Every part of the complex automotive business ecosystem—from parts suppliers and manufacturers to customers and safety regulators—relies on a network of transactions and knowledge that starts long before a vehicle is manufactured and extends far beyond its purchase. That network is growing. From support for evolving hardware and services to understanding the provenance and location of defective or counterfeit parts, the amount of data that the automotive industry must track is exploding.

Blockchain can help build efficiency, transparency, and trust by using a shared and permissioned record of ownership, location, and movement of parts and goods. The versatility of blockchain records makes them perfect for keeping up with innovative new business models.

Mobility Service

Modern cars are more than transportation devices; they are complex and networked software platforms on wheels. Vehicles increasingly need to incorporate secure and seamless mobility services, including micropayments and other interactions with ride-sharing services, smart transportation infrastructure, and electric vehicle charging.

IBM has announced a partnership with ZF and UBS Bank to implement a blockchain-backed car eWallet service that is delivered through IBM Cloud, enabling cashless micropayments for tolls, congestion fees, electric charging fees, parking fees, and making payments between vehicles. The system also allows a vehicle to be used as a secure drop point for packages, when the vehicle owner gives the package delivery service permission to access its trunk.

Provenance Tracking

Auto manufacturing is truly global. Parts are sourced worldwide, and completed vehicles might be driven anywhere on earth. To contend with counterfeit parts and defect-driven product recalls, traceability is crucial in understanding a vehicle's post-sale movements. To maintain safety and reliability, makers must track vehicle movements for both regulators and purchasers. If a component safety issue arises, blockchain technology can help both automobile makers and parts suppliers quickly discover where the parts are.

Analogous to the developments occurring in the auto industry, Boeing is implementing an IBM Blockchain–based solution that will make information from across the aircraft supply chain accessible to component vendors, aircraft owners and maintainers, and regulators.

Travel and Transportation

The travel and transportation environments have millions of moving parts. Blockchain technologies can help each part move in the safe, secure, efficient, and frictionless ways that are necessary for business success and customer satisfaction.

Consider the airline industry's practice of interlining, also known as *interline ticketing* and *interline booking*, is a voluntary commercial agreement between individual airlines to handle passengers traveling on itineraries that require multiple flights on multiple airlines. As part of this practice, multiple business-to-business transactions occur between booking agents, air carriers, credit card companies, and airports. The results often lead to complexity, errors, or transaction disputes. In contrast, when all parties use the same data in a blockchain environment, common information visibility and sharing can eliminate inconsistencies. Whether used on land, at sea, or in the air, blockchain technology speeds transactions, eliminates fraud, and helps streamline transportation operations with an immutable, trustworthy, and secure system that builds trust among parties.

Personnel Coordination

Passenger and cargo safety are paramount in every form of transportation, but crew training and certification can involve multiple agencies over long periods. Every transport terminal is a hive of activity, with personnel who are employed by a wide range of companies with duties as diverse as fuel delivery, ticket taking, catering, shuttle-cart driving, cleaning, and more. Each employee requires vetting for security, and all of their activities must be coordinated.

With its shared and immutable ledger that prevents entries from being changed or falsified, blockchain can provide the verification and insight that transportation companies need. Certificates and licenses can be stored for each crew member and verified and updated as more training occurs. Blockchain provides a central management mechanism, with

visibility into the common information that is necessary for settling disputes over pay, work status, or other issues that might arise.

Cargo Handling

Shipping goods involves multiple parties, including senders, receivers, carriers, and regulators. Given the involvement of so many entities, each with a different records system, blockchain can help track the location and condition of cargo. Using shared records of ownership, location, and movement, carriers can improve their load utilization, and senders and receivers can speed delivery by clearing customs in transit instead of waiting at the terminal.

For example, dnata (Dubai National Air Transport Association), a global provider of ground handling, cargo, travel, and flight catering services for more than 400 airlines, teamed with IBM to eliminate redundant data and improve visibility and transparency for cargo services by using blockchain. The results streamlined and simplified the processes from the point of origin to the final destination. The blockchain solution achieves this task by digitizing the supply chain and by using a peer-to-peer network to manage and track each cargo container's path.
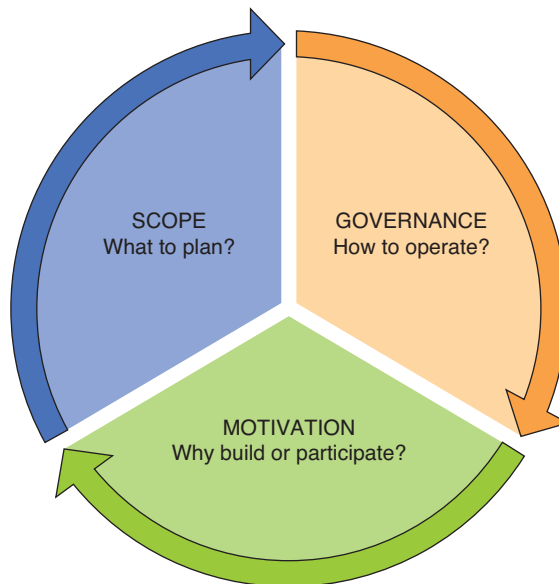
CHALLENGES

The primary challenges with the application of blockchain are not about having a perfect and matured technology: The evolution of blockchain technology will undoubtedly continue, much as Internet technology continues to advance nearly four decades after its first introduction. Blockchain technology has been used for several years as an underlying foundation for cryptocurrency application, and lately many organizations have advanced it to ensure its enterprise readiness for other industries. The key challenges are choosing the right scope, having the right motivation for a business and its participants, ensuring the right governance structure, and having the correct team and technology in place. These challenges can be conquered if you make deliberate and diligent efforts to manage the

blockchain network effectively and focus on driving the ultimate transformation that you envisioned.

As shown in Figure 2.3, addressing the challenges involves three aspects: The scope helps you determine what plan you should make for a blockchain network, governance defines how you should operate it, and motivation drives why you should build or participate in it.

Figure 2.3 Addressing the challenges.

SCOPE

Although blockchain has the potential to disrupt many businesses, current business policies and requirements might not immediately support the transformation. Also, blockchain might not be feasible for multiple reasons, such as existing government, business, and legal agreements and laws, exposure, global reputation, bureaucracy, and partnerships. Therefore, it is important to select the right scope so that you can deliver success incrementally, albeit with a big dream in mind for transformation.

The scope selection exercise reflects your vision and business outcome expectations. However, given that blockchain touches critical elements of an organization's structure, business model, and ecosystem, it is important to consider the scope of each of these items in the context of your desired short-term and long-term business outcomes.

The success of a blockchain project is determined by the correct selection of scope, so define your minimal viable product (MVP) and minimal viable ecosystem (MVE) with a clear start state of your blockchain project; determine your Specific, Measurable, Achievable, Results-focused, and Time-bound (SMART) end goal; and identify key activities that must be performed to pinpoint the following items:

- Vulnerabilities and inefficiencies to identify disruptive business use cases
- Business network participants and ecosystem readiness
- Business model and differentiation needed to compete
- Governance plan and policy for cooperation and trust
- Operational plan, including costs and responsibilities
- Technology and vendor selection

MOTIVATION

The right incentive plan drives motivation to establish the correct behavior, trust, and cooperation in any business network involving consumers and partners. A blockchain network includes both founders of the network and participants. However, because of the nature of the distributed organizations and the decentralized ecosystem that is ready for shared gain and shared pain, it is important to develop an appropriate incentive structure so that everyone is motivated and acts as a trusted partner in the network. Bad actors in a network can jeopardize your ability to achieve your goals within the planned time, costs, and resources conditions.

Incentives in blockchain business networks are not monetary, but might be instead visibility, access, share, and exchange rights. For example, a

regulator might want access to and visibility of transactions for compliance purpose, a nonfounding member might want to participate and share its assets for exchange or return value in a network, and a founding member such as a government agency might want specific rights for a business policy or transaction while maintaining trust and transparency.

A token can be issued as an incentive to grow transactions, assets exchange, or the value of transactions in a network. Tokens represent equity or rewards in the systems, and the value of those rewards grow if everyone is performing at an expected or higher level. These tokens are used in managing the loyalty points in retail or consumer businesses, carbon credits in energy trading, credit scores in a financial system, course or merit certification in an educational system, or even a brand or a social image in a reputation system.

To drive sustained motivation in a blockchain network, you must evaluate the following aspects:

- Who brings which data, knowledge, or assets to the network?
- What is the value of their contributions to the network?
- What do they expect in return?
- What will keep them motivated to be trusted participants?
- What incentives you can offer for short-term versus long-term engagement?
- What policies can enable automated incentive allocation?

GOVERNANCE

A good business depends on having a good governance structure and a team of trusted partners. The success and failure of a business entirely depends on its ability to develop an ecosystem that is properly governed and incentivized.

Governance is the most critical and compulsory requirement for a blockchain project's success because it maintains a decentralized property with self-executable business and legal contracts that are embodied in the transactions as smart contracts. Although this approach drives automation, speed, and efficiency in a business network, it is critical to understand how the smart contracts are developed and managed as part of the governance structure. In unforeseeable situations, when you have trusted and motivated partners in a network, consensus building becomes much easier and occurs much faster.

The risk in a blockchain project is directly proportional to the governance complexity that drives increased uncertainty, delays, and costs. The public blockchain networks have higher risks than their private, permissioned, or hybrid counterparts due to the difficulty in governance efficacy. Although some use cases are perfect for public blockchain, others are not. Unless you plan carefully, having an open, public, and decentralized governance structure might not be feasible for many of your enterprise use cases because of privacy, compliance, and regulatory requirements. Because many industries' regulators are investigating blockchain technology implications for their compliance requirements and addressing them, your network must adhere to the existing compliance policies.

A governance structure in a blockchain network can include multiple levels of workgroups that should have a dedicated focus to address the following specific concerns:

- The disruptive nature of the envisioned business model and its impact on participants
- The roles and accountability of participants
- Decision rights
- Shared incentives and disincentives
- Intellectual property rights and liabilities
- Existing regulatory and compliance policies and awareness of future changes
- Technical design and architecture

TECHNOLOGY

Technology concerns are not the primary inhibitors of the adoption of blockchain. Indeed, many organizations, including IBM, have made deliberate efforts to make blockchain ready for enterprise usage by effectively addressing (or being in the process of addressing) implementation, deployment, integration, and operation concerns.

Many businesses might be overwhelmed by the technical challenges regarding privacy, scale, or throughput, such as the number of transactions, interoperability, consensus, contract verification, tools, support, and quantum computing threats. However, many of these concerns have already been addressed by many vendors in various implementations of blockchain technologies.

Permissioned and private blockchains can address the privacy concerns by maintaining the anonymity of a participant while ensuring the validation of a transaction from an authorized participant or by using obfuscation technology to restrict the exposure of private information. In public blockchain implementation, businesses can choose to implement off-chain execution—a practice in which they keep only transactional information recorded on the public ledger, while simultaneously maintaining a shadow ledger to keep identity information private.

The scalability or throughput of the blockchain network primarily depends on the levels of security and cryptography that are applied, as well as the efficiency of the consensus algorithm. If you loosen the security strength, the throughput increases. The proof-of-work module is the primary compute- and time-intensive task that drives the throughput, and many public blockchain implementations for cryptocurrency have single-digit transactions that are validated and recorded per second. By comparison, a robust, enterprise-ready, and permissioned blockchain like Hyperledger is ready to serve more than a thousand transactions per second without compromising any security.

Also, you can run multiple channels in a parallel peer-to-peer scheme. This model addresses throughput concerns and enables blockchain readiness for many enterprise use cases.

Interoperability is another concern, given the existence of different implementations of blockchain technologies, such as Ethereum, Hyperledger, R3's Corda, and Ripple. Although business applications and networks are built on different blockchain bases, eventually they must interoperate in the broader economy. As an analogy, think about how we started with private and closed intranets, which were then called upon to interoperate on the Internet. In the blockchain world, standards and technology groups are already working to address these types of concerns.

Consensus mechanisms and corresponding algorithms are quite advanced in the current technology implementations. For example, Hyperledger addresses fault tolerance and resilience concerns by providing a modular foundation where peers are divided into separate groups that are based on their roles and smart contracts are tailored and run. Contract verifications are fairly managed by emerging smart contract programming languages. Tools, deployment, and operations support is provided by many vendors and open source communities.

To some extent, quantum computing poses a threat to blockchain security because quantum computers can hack any traditional system's cryptography. Nevertheless, post-quantum cryptography, such as lattice cryptography techniques, is available to address quantum computing threats.

Although many technical challenges can be addressed with public, private, permissioned, or hybrid blockchain models, you should be able to clearly identify the following items in your environment:

• The architectural needs of your business use case—that is, whether you use a public, private, permissioned, or hybrid blockchain network
• Open and standard technologies requirements

- Privacy requirements

- Scalability and throughput needs

- Integration capability with existing systems and applications

- End-to-end support for implementation, deployment, and operations

- Interoperability needs

CHAPTER SUMMARY

This chapter covered blockchain technology's disruptive elements that drive transformation across traditional organizational structures, business models, and ecosystems. These characteristics fundamentally open endless opportunities in many industries to innovate and challenge the status quo. The primary challenges for a blockchain project's success are specific to the scope, motivation, and governance rather than to the technology.

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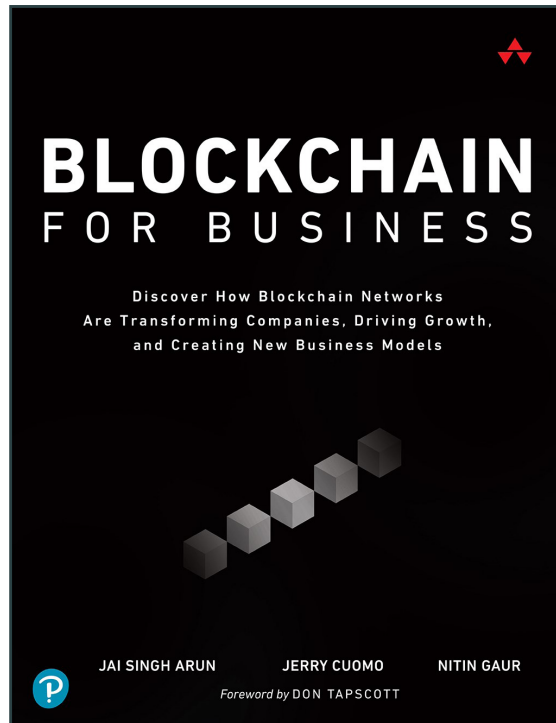
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